SANTA CLARA VALLEY WATER DISTRICT

FAHCE Temperature Modeling Report for Stevens Creek Reservoir and Stevens Creek

by

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1 Introduction

According to the project description, the Fish and Aquatic Habitat Collaborative Effort (FAHCE) project is requesting that Hydraulic Engineering Unit perform temperature modeling for Stevens Creek Reservoir and Stevens Creek in support of CEQA/NEPA alternative analysis of reservoir operations release strategies as part of the Draft Settlement Agreement (DSA). This study is conducted based on the current reservoir configuration with a single intake at the reservoir.

There are currently three reservoir operating strategies being considered for alternative analysis:

1) **DSA**: original creek temperature criteria with daily average not exceeding 19 °C and daily maximum not exceeding 22 °C at Highway 280;
2) **DSA'**: relaxed creek temperature criteria with daily average not exceeding 22 °C and daily maximum not exceeding 24 °C at Highway 280, and an elevated spring out-migration release for May;
3) **ALT 4C**: maximum extent of wetted creek and duration, creek temperature criteria do not apply, however they will be considered as part of the operating strategy evaluation performed during the CEQA/NEPA alternative analysis.

In order to facilitate alternative analysis of these reservoir operating strategies, the FAHCE project team has developed following scope of work for the temperature modeling efforts:

1) Hydraulic Engineering Unit will develop six curves that describe Stevens Creek Reservoir releases in cubic feet per second (cfs) as a function of reservoir storage volume in acre-feet (AF), creek temperature criteria, and two weather scenarios.
2) Hydraulic Engineering Unit will provide creek temperatures for release schedules associated with the maximum extent and duration operating strategy (ALT 4C). The creek temperatures will be provided for a low, medium and full May 1 reservoir storage condition, and under an average and extreme weather pattern, respectively.

2 Modeling Approach and Results for Task 1

For task 1, we were requested to develop six curves that describe Stevens Creek Reservoir releases as a function of reservoir storage volume, creek temperature criteria, and two weather scenarios. The curves should be comprised of a range of low, medium and high May 1 and June 1 storage volumes that would adequately describe the storage and release relationships by meeting creek temperature criteria associated with each operating strategy.

Modeling Approach -- CE-QUAL-W2 program was used in this study to model the release water temperature from Stevens Creek reservoir into Stevens Creek. CE-QUAL-W2 is a two-dimensional (longitudinal/vertical), laterally averaged, hydrodynamic and water quality model. The first version 1.0 was released by the Environmental and Hydraulic Laboratories, U.S. Army Corps of Engineers Waterway Experiment Station (WES), in 1986, and the current version is 3.6, which is the version we used in this study. As revealed from aerial photos of Stevens Creek Reservoir, the geometry of this reservoir is relatively long and narrow, and CE-QUAL-W2 should be an appropriate modeling tool for this waterbody [1]. A CE-QUAL-W2 model has been set up and calibrated for Stevens Creek Reservoir in a previous study by L. Hong [2], and this established model was continuously used in this study to perform the reservoir temperature modeling efforts.

Selection of Years for Simulation -- Reservoir storage data on first day of each month between years 1986 – 2008 has been provided by Operations Planning and Analysis Unit (OPAU). All the reservoir storage data was derived from midnight gage readings in the reservoir and the reservoir rating curve. As a new survey was conducted in year 2003, a new rating curve was developed and applied to interpret storage data since November 2003. Previous survey was completed by Aelytec on November 20, 1985. In order to reconcile the inconsistency in the provided storage data as two sets of rating curves have been applied before and after November 2003, the new rating curve was applied to derive the storage data for 10 years back from 2003 (1992 – 2003) assuming the new survey reflects more current reservoir geometry and provides more accurate storage measurements for this time period. After this adjustment, Table 1 shows the storage record on first day of each month between years 1986 – 2008 for Stevens Creek Reservoir.

Table 1 First Day of the Month Storage Record for Stevens Creek Reservoir

	Storage Data on the First Day of the Month (acre-feet)											
Year	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
1986	59	354	3572	3443	3105	2674	1619	748	668	601	545	456
1987	412	456	853	1102	1064	937	770	632	505	268	105	97
1988	424	901	960	921	889	742	628	482	395	318	279	269
1989	378	505	612	1109	1082	982	616	700	495	433	463	582
1990	550	833	1218	1359	1380	1210	1000	718	531	454	383	338
1991	325	318	297	2210	2414	2201	1856	1371	922	609	490	427
1992	427	588	3094	3128	3120	3041	2664	2282	1851	1517	1371	1255
1993	1657	3147	3157	3138	3085	3111	2871	2408	1970	1838	1650	1517
1994	1555	1542	2321	2376	2337	2204	1730	1330	1016	815	647	643
1995	692	3157	3128	2996	3023	2898	2880	2698	2345	1984	1650	1480
1996	1991	3147	3147	3128	3067	3076	2979	2681	2267	1948	1723	1796
1997	3195	3067	2943	3032	2916	2767	2506	2100	1703	1347	1065	1065
1998	1359	2100	2489	3050	3076	3085	2750	2400	1796	1232	802	622
1999	581	1021	2580	3059	3094	3059	2943	2672	2360	2041	1650	1306
2000	977	1574	2656	3041	3076	2854	2767	2555	2298	2020	1865	1736
2001	1599	1899	2925	2836	2934	2845	2639	2384	2122	1872	1631	1644
2002	1984	2100	2212	2481	2555	2473	2259	1963	1650	1353	1091	1128
2003	2122	2122	2020	2235	3147	3138	3111	2934	2689	2465	2257	2164
2004	2152	1792	3080	3069	3120	3009	2797	2506	2199	1906	1725	1567
2005	2350	2558	2811	3149	3153	3139	3129	3035	2837	2629	2364	2198
2006	2806	2455	2920	3067	3147	3129	3074	2861	2480	2098	1792	1565
2007	1525	1372	1973	2089	1928	1803	1663	1523	1389	1266	1193	1117
2008	1096	2522	3014	2925	2514	2352	2160	1918	1670	1431	1154	1021

Notes:

Adjusted storage data based on the new rating curve developed in 2003.

- The original capacity of Stevens Creek Reservoir is 4000 acre-feet, and its current capacity is 3138 acre-feet based on the 2003 survey.
- *Data source*: Operations Planning and Analysis Unit data record, SCVWD

Statistical analysis of the historical reservoir storage data (1986-2008) [Figure 1] shows that year 2001 is close to an average year in terms of May 1 storage volume with an exceedance probability of 0.55; year 2007 is a pretty dry year at the beginning of May with an exceedance probability of 0.82 for May 1 storage volume; and year 2004 has an almost full reservoir (3120 acre-feet) at the beginning of the summer season with an exceedance probability of 0.14. Since data records of inflow and outflow temperatures for Stevens Creek Reservoir are only available since 1999, as part of crucial input data for the CE-QUAL-W2 model, years starting from 1999 are more preferable when selecting a representative span of low, medium and high May 1 reservoir storage volume. One more year 2002 with a May 1 storage volume of 2555 acre-feet was also included in the modeling exercise to help better define the relationship between storage volume and release rate for various operating strategies.

The same methodology was applied to analyze the June 1 storage records for the last 23 years, and the same set of years 2001, 2002, 2004, and 2007 was chosen to represent a range of low, medium and high June 1 storage volume for the reservoir [Figure 2].

The simulation of W2 model for year 2001, 2002, 2004 and 2007 started from the following dates: 5/10/2001, 4/30/2002, 5/3/2004, and 4/24/2007, respectively. These dates are the closest ones to May 1 when vertical temperature profile of the reservoir was measured in the field. The measured vertical temperature profile was used as initial conditions for the W2 model simulation.

Determination of Two Weather Conditions -- As explained in the previous report [2], hourly meteorological data sets from 1986 to 2008 were purchased from National Climatic Data Center (NCDC) for the San Jose Airport Station (SJC). The summer averages of daily maximum air temperatures for 1986 – 2008 shows that year 1993 had the hottest summer and year 2006 had an average summer weather condition in the last 23 years. The average air temperature of the extremely hot summer of 1993 is about 3 °C higher than that of the average summer of 2006. For this study, the meteorological data set of year 2006 was selected to represent the average summer weather conditions, and the 1993 meteorological data set was selected to represent the extremely hot summer conditions.

Modeling Results and Curve Development -- Based on the W2 model simulation results, the six curves were developed as follows: curves ***A*** and ***B*** depicted May 1 storage and release rate as applied to the DSA operating strategy temperature criteria under average and extreme summer weather scenarios. Curves ***C*** and ***D*** showed the relationship between May 1 storage and release rate as applied to the DSA' operating strategy with relaxed water temperature criteria and May spring out-migration under average and extreme summer weather scenarios. Curves ***E*** and ***F*** were also applied to the DSA' operating strategy while depicted June 1 storage and release rate under two weather conditions.

Previous temperature modeling study for Stevens Creek Reservoir and Stevens Creek [2] suggested that creek temperature in Stevens Creek is controlled by the release water temperature from the reservoir. Local air temperature data collected by the District Staff in the last 10 years showed that for an average summer, daily air temperature in the Stevens Creek area typically stays below 22.5 °C. The creek temperature modeling with SSTMP showed that

under average summer conditions, as long as the release water temperature from the reservoir outlet meets the creek temperature criteria, the creek temperature should not exceed the criteria within the creek reach down to Highway 280. Hence in this study, the release water temperature from the reservoir was simulated by W2 model and was used to determine if an operating strategy, i.e. water release rate and schedule from the reservoir, meets the corresponding creek temperature criteria in Stevens Creek for various scenarios.

a. **Curve *A* (DSA operating strategy, May 1 storage, average weather conditions)**: it depicted summer reservoir release in cfs as a function of May 1 storage volume in a range of low, medium and high reservoir volume in AF under average summer weather conditions, with the criteria of not exceeding 19 °C daily average creek temperature, and not exceeding 22 °C daily maximum creek temperature. As discussed above, year 2007 represents a year with low May 1 storage volume, year 2001 represents a year with medium May 1 storage volume, and year 2004 represents a year with high May 1 storage volume. Year 2002, with a May 1 storage volume a little bit less than the medium level, was also included in the simulation for a better curve definition. Year 2006 meteorological data were used in this simulation to represent average summer weather conditions. By using the creek temperature criteria applied to the DSA operating strategy, W2 model simulation was performed for each selected year to determine the corresponding summer reservoir release rate. The modeling results are summarized in Table 2, and curve ***A*** is presented in Figure 3.

Table 2 W2 Modeling Results for Curve *A* Development (average summer weather conditions)

Year	May 1 Storage Volume (AF) – from low to high	May 1 Storage Exceedance Probability	Release Rate Determined by Model Simulation (cfs)
2007	1928	82%	1.7
2002	2555	64%	2.5
2001	2934	55%	3.5
2004	3120	14%	3.9

b. **Curve *B* (DSA operating strategy, May 1 storage, extreme weather conditions)**: Similar to Curve ***A***, it depicted summer reservoir release in cfs as a function of May 1 storage volume in AF under extreme summer weather conditions, in compliance with the creek temperature criteria applied to the DSA operating strategy. The same set of years (2007, 2002, 2001 and 2004) was included in the model simulation. Year 1993 meteorological data were used in simulations to represent extreme summer weather conditions. The modeling results are summarized in Table 3, and curve ***B*** is presented in Figure 4. It was found in the previous study [2] that a 3 °C increase of average air temperature would result in 0.3 °C increase in release water temperature; in order to meet the temperature criteria, the release rate needed to be reduced by 0.1 cfs. The same trend was also found in this study. As the average air temperature in the extreme year like 1993 is about 3 °C higher than that of the average year 2006, the water release rate determined from the W2 model simulation for Curve ***B*** is 0.1 cfs lower than that in Curve ***A*** for a given year.

Table 3 W2 Modeling Results for Curve *B* Development (extreme summer weather conditions)

Year	May 1 Storage Volume (AF) – from low to high	May 1 Storage Exceedance Probability	Release Rate Determined by Model Simulation (cfs)
2007	1928	82%	1.6
2002	2555	64%	2.4
2001	2934	55%	3.4
2004	3120	14%	3.8

c. **Curve *C* (DSA' relaxed creek temperature criteria and spring out-migration, May 1 storage, average weather conditions)**: it depicted summer reservoir release in cfs as a function of May 1 storage volume in a range of low, medium and high reservoir volume in AF under average summer weather conditions, with the criteria of not exceeding 22 °C daily average creek temperature, and not exceeding 24 °C daily maximum creek temperature. The differences between Curve ***A*** and Curve ***C*** are that 1) for the DSA' operating strategy, the creek temperature criteria has been relaxed from 19 °C to 22 °C for daily average, and from 22 °C to 24 °C for daily maximum; 2) there is a spring out-migration period for the DSA' operating strategy where 7 cfs release rate will be implemented during May. With these changes, W2 model simulation was performed for the same set of selected years to determine the corresponding summer reservoir release rate starting June 1. The modeling results are summarized in Table 4, and curve ***C*** is presented in Figure 5.

Table 4 W2 Modeling Results for Curve *C* and Curve *E* Development (average summer weather conditions)

Year	May 1 Storage Volume (AF) – from low to high	June 1 Storage Volume (AF) with 7 cfs Release in May	Release Rate Starting from June 1 Determined by Model Simulation (cfs)
2007	1928	1498	2.0
2002	2555	2125	2.9
2001	2934	2504	4.2
2004	3120	2690	4.5

d. **Curve *D* (DSA' relaxed creek temperature criteria and spring out-migration, May 1 storage, extreme weather conditions)**: Similar to Curve ***C***, it depicted summer reservoir release in cfs as a function of May 1 storage volume in AF under extreme summer weather conditions, in compliance with the relaxed creek temperature criteria applied to the DSA' operating strategy. Year 1993 meteorological data were used in simulations to represent extreme summer weather conditions. The modeling results are summarized in Table 5, and curve ***D*** is presented in Figure 6.

Table 5 W2 Modeling Results for Curve *D* and Curve *F* Development (extreme summer weather conditions)

Year	May 1 Storage Volume (AF) – from low to high	June 1 Storage Volume (AF) with 7 cfs Release in May	Release Rate Starting from June 1 Determined by Model Simulation (cfs)
2007	1928	1498	1.9
2002	2555	2125	2.8
2001	2934	2504	4.1
2004	3120	2690	4.4

e. **Curve *E* (DSA' relaxed creek temperature criteria and spring out-migration, June 1 storage, average weather conditions)**: this curve is basically same as Curve ***C*** except that it depicted summer reservoir release rate as a function of June 1 storage volume instead of May 1 storage volume. With the release rate of 7 cfs in May during the spring out-migration period, June 1 storage volume was easily calculated based on the May 1 storage volume. The modeling results are same as those for Curve ***C*** and summarized in Table 4, and curve ***E*** is presented in Figure 7.

f. **Curve *F* (DSA' relaxed creek temperature criteria and spring out-migration, June 1 storage, extreme weather conditions)**: this curve is basically same as Curve ***D*** except that it depicted summer reservoir release rate as a function of June 1 storage volume instead of May 1 storage volume. With the release rate of 7 cfs in May during the spring out-migration period, June 1 storage volume was easily calculated based on the May 1 storage volume. Year 1993 meteorological data were used in simulations to represent extreme summer weather conditions. The modeling results are the same as those for Curve ***D*** and summarized in Table 6, and curve ***F*** is presented in Figure 8.

In addition to these six curves, a different release rate – 4 cfs instead of 7 cfs in May - during the spring out-migration period was tested for Curve ***C*** and Curve ***E*** (average summer weather conditions) per project team's request. The modeling results are summarized in Table 6, and Curve C' and Curve E' are presented in Figure 9 and Figure 10.

Table 6 W2 Modeling Results for Curve *C'* and *E'* Development (average summer weather conditions)

Year	May 1 Storage Volume (AF) – from low to high	June 1 Storage Volume (AF) with 4 cfs Release in May	Release Rate Starting from June 1 Determined by Model Simulation (cfs)
2007	1928	1682	2.3
2002	2555	2309	3.2
2001	2934	2688	4.7
2004	3120	2874	5.2

3 Model Approach and Results for Task 2

For task 2, we were requested to provide creek temperature predictions for summer reservoir release schedules associated with the maximum extent and duration operating strategy (ALT 4C). As discussed in section 2, per project team's concurrence, three years have been selected to represent a range of low, medium, and high May 1 storage volume in Stevens Creek Reservoir: year 2001 represents an average year, year 2004 represents a wet year, and year 2007 represents a dry year. The release schedules for these three hydrological cases were provided by the project team: for an average year like 2001, the reservoir water is released with a rate of 6 cfs since May; for a wet year like 2004, the reservoir water rate is also 6 cfs since May; and for a dry year like 2007, the reservoir water will be released at a rate 6 cfs in May, and 2 cfs from June to the end of the year. The creek temperature predictions were requested for two weather scenarios: an average and an extreme summer weather pattern.

Modeling Approach – CE-QUAL-W2 program was used to simulate release water temperature from the reservoir for three hydrological cases under two weather scenarios with the corresponding release schedule. Then Stream Segment Temperature Model (SSTMP) was used to follow the release water from the reservoir and to examine the water temperature change within the reach of Stevens Creek between the reservoir outlet structure and Highway 280. SSTMP was developed by U.S. Fish and Wildlife Services [3], and the most updated version 2.0 (revised in August 2002) was used in this study. Similar to the CE-QUAL-W2 model, a SSTMP model has been set up and calibrated for Stevens Creek between Stevens Creek Reservoir and Highway 280 in the previous study by L. Hong [2], and this established model was continuously used in this study to predict creek temperatures of different scenarios.

Modeling Assumptions – SSTMP has been designed to handle only single stream segments for a single time period (e.g., month, week, day) in any given run. It predicts the mean daily water temperature at specified distance downstream. It also estimates the daily maximum temperatures, either by using the user-provided maximum air temperature or using the program-estimated maximum air temperature. In order to facilitate this modeling exercise, we made the following conservative assumptions:

- For each scenario, the day with the highest release water temperature from the reservoir for each month was selected for creek temperature simulation. Reservoir release water temperature was provided by the W2 model, and the monthly highest release water temperatures were then used as the inflow temperature data for SSTMP.
- For each scenario, air temperature on the hottest day within each month was used as the input air temperature data for SSTMP. It was also found in the previous study [2] that better representation of the air temperature should be the average air temperature of the hottest day and the day before as the response in the creek temperature to the rising air temperature is not instantaneous, typically delayed by one day. Therefore to be more precise, the input air temperature data used in SSTMP for this study is the average air temperature of the hottest day within each month and the day before. This method was applied to both the daily average and the daily maximum air temperature required by SSTMP.
- Ideally, the input air temperature data for SSTMP should be collected from local temperature logging stations within the creek reach. However due to lack of complete data set from local logging stations, the air temperature data measured at SJC station was used instead with corresponding adjustment. It was found from the previous study [2] that air temperature data between SJC station and local logging station correlates by following this equation: $T_{\text{local logging station}} = 0.9064 * (T_{\text{SJC station}} + 0.2033)$. Therefore all the air

temperature data from SJC station were adjusted to those from local logging stations by using this relationship before modeling input. Table 7 summarized the input air temperature data required by SSTMP.

Table 7 SSTMP Air Temperature Data Input for Extreme Weather Condition and Average Weather Condition

Extreme Weather Condition (e.g. Year 1993)					
	Jun	**Jul**	**Aug**	**Sep**	**Oct**
Date of the Monthly Hottest Day	**6/25**	**7/31**	**8/1**	**9/8**	**10/29**
Daily Avg. Air T on the Hottest Day (°C)	31.49	30.47	32.41	25.82	25.38
Daily Avg. Air T on the day before (°C)	29.97	25.47	30.47	24.32	21.26
Avg. Air T (Daily Avg.) for SSTMP * (°C)	28.0	25.5	28.7	22.9	21.3
Daily Max. Air T on the Hottest Day (°C)	38.89	38.89	40.00	32.22	30.56
Daily Max. Air T on the day before (°C)	36.11	32.22	38.89	32.22	30.00
Avg. Air T (Daily Max.) for SSTMP * (°C)	34.2	32.4	35.9	29.4	27.6
Average Weather Condition (e.g. Year 2006)					
	Jun	**Jul**	**Aug**	**Sep**	**Oct**
Date of the Monthly Hottest Day	**6/22**	**7/22**	**8/9**	**9/12**	**10/21**
Daily Avg. Air T on the Hottest Day (°C)	27.11	30.67	25.87	23.94	19.40
Daily Avg. Air T on the day before (°C)	25.37	27.45	20.42	21.48	19.14
Avg. Air T (Daily Avg.) for SSTMP * (°C)	24.0	26.5	21.2	20.8	17.7
Daily Max. Air T on the Hottest Day (°C)	37.22	38.89	35.00	33.89	28.89
Daily Max. Air T on the day before (°C)	35.00	35.00	27.22	31.11	28.89
Avg. Air T (Daily Max.) for SSTMP * (°C)	32.9	33.7	28.4	29.6	26.4

Notes:

* Air temperature input for SSTMP is calculated by averaging air temperatures on the monthly hottest day and on the day before, and then being corrected by the correlation of air temperature data between SJC station and local logging station.

Modeling Results – SSTMP modeling results for Task 2 have been presented in Table 8 for the average summer weather and in Table 9 for the extreme summer weather. With the release schedule specified for each reservoir storage condition, W2 model simulations showed that for average storage year like 2001, the lowest storage volume would be 724.6 acre-feet on 11/23/2001; for wet storage year like 2004, the lowest storage volume would be 855.1 acre-feet on 11/15/2004; and for dry storage year 2001, the lowest storage volume would be 754.6 acre-feet on 12/31/2007. Therefore the storage volume in the reservoir would not drop below 500 acre-feet for all these scenarios.

Table 8 SSTMP Modeling Results for Average Weather Condition (e.g. 2006 Meteorological Data)

Average Storage Conditions: Year 2001

Release Schedule: 6 cfs from May to the end of the year

Month	Release Water Temp from the Reservoir (°C)	Monthly Highest Daily Avg. Air Temp (°C)	Monthly Highest Daily Max. Air Temp (°C)	Predicted Water Temp at Hwy 280 (°C)	
				Avg	Max
Jun	11.16	23.97	32.91	15.99	21.75
Jul	14.23	26.53	33.67	18.87	23.62
Aug	20.47	21.16	28.38	19.07	22.88
Sep	23.53	20.77	29.64	19.97	23.94
Oct	21.62	17.65	26.37	17.83	21.81

Wet Storage Conditions: Year 2004

Release Schedule: 6 cfs from May to the end of the year

Month	Release Water Temp from the Reservoir (°C)	Monthly Highest Daily Avg. Air Temp (°C)	Monthly Highest Daily Max. Air Temp (°C)	Predicted Water Temp at Hwy 280 (°C)	
				Avg	Max
Jun	11.74	23.97	32.91	16.25	21.91
Jul	14.13	26.53	33.67	18.83	23.59
Aug	19.64	21.16	28.38	18.74	22.64
Sep	23.35	20.77	29.64	19.89	23.88
Oct	21.1	17.65	26.37	17.61	21.65

Dry Storage Conditions: Year 2007

Release Schedule: 6 cfs in May, and 2 cfs from June to the end of year

Month	Release Water Temp from the Reservoir (°C)	Monthly Highest Daily Avg. Air Temp (°C)	Monthly Highest Daily Max. Air Temp (°C)	Predicted Water Temp at Hwy 280 (°C)	
				Avg	Max
Jun	13.19	23.97	32.91	18.46	23.6
Jul	15.51	26.53	33.67	21.12	25.43
Aug	18.16	21.16	28.38	17.96	22.44
Sep	22.01	20.77	29.64	17.74	22.7
Oct	21.33	17.65	26.37	15.64	20.76

Table 9 SSTMP Modeling Results for Extreme Weather Condition (e.g. 1993 Meteorological Data)

Average Storage Conditions: Year 2001

Release Schedule: 6 cfs from May to the end of the year

Month	Release Water Temp from the Reservoir (°C)	Monthly Highest Daily Avg. Air Temp (°C)	Monthly Highest Daily Max. Air Temp (°C)	Predicted Water Temp at Hwy 280 (°C)	
				Avg	Max
Jun	11.12	28.04	34.17	17.98	22.59
Jul	14.12	25.53	32.41	18.34	22.96
Aug	20.10	28.68	35.94	22.58	26.6
Sep	24.20	22.91	29.39	21.1	24.3
Oct	22.11	21.32	27.63	19.48	22.74

Wet Storage Conditions: Year 2004

Release Schedule: 6 cfs from May to the end of the year

Month	Release Water Temp from the Reservoir (°C)	Monthly Highest Daily Avg. Air Temp (°C)	Monthly Highest Daily Max. Air Temp (°C)	Predicted Water Temp at Hwy 280 (°C)	
				Avg	Max
Jun	11.73	28.04	34.17	18.24	22.77
Jul	14.07	25.53	32.41	18.32	22.94
Aug	19.15	28.68	35.94	22.23	26.36
Sep	23.87	22.91	29.39	20.98	24.21
Oct	21.79	21.32	27.63	19.34	22.64

Dry Storage Conditions: Year 2007

Release Schedule: 6 cfs in May, and 2 cfs from June to the end of year

Month	Release Water Temp from the Reservoir (°C)	Monthly Highest Daily Avg. Air Temp (°C)	Monthly Highest Daily Max. Air Temp (°C)	Predicted Water Temp at Hwy 280 (°C)	
				Avg	Max
Jun	13.2	28.04	34.17	21.23	25.04
Jul	15.53	25.53	32.41	20.43	24.7
Aug	18.13	28.68	35.94	23.28	27.33
Sep	21.65	22.91	29.39	19.11	23.09
Oct	21.58	21.32	27.63	17.94	21.99

4 Reference

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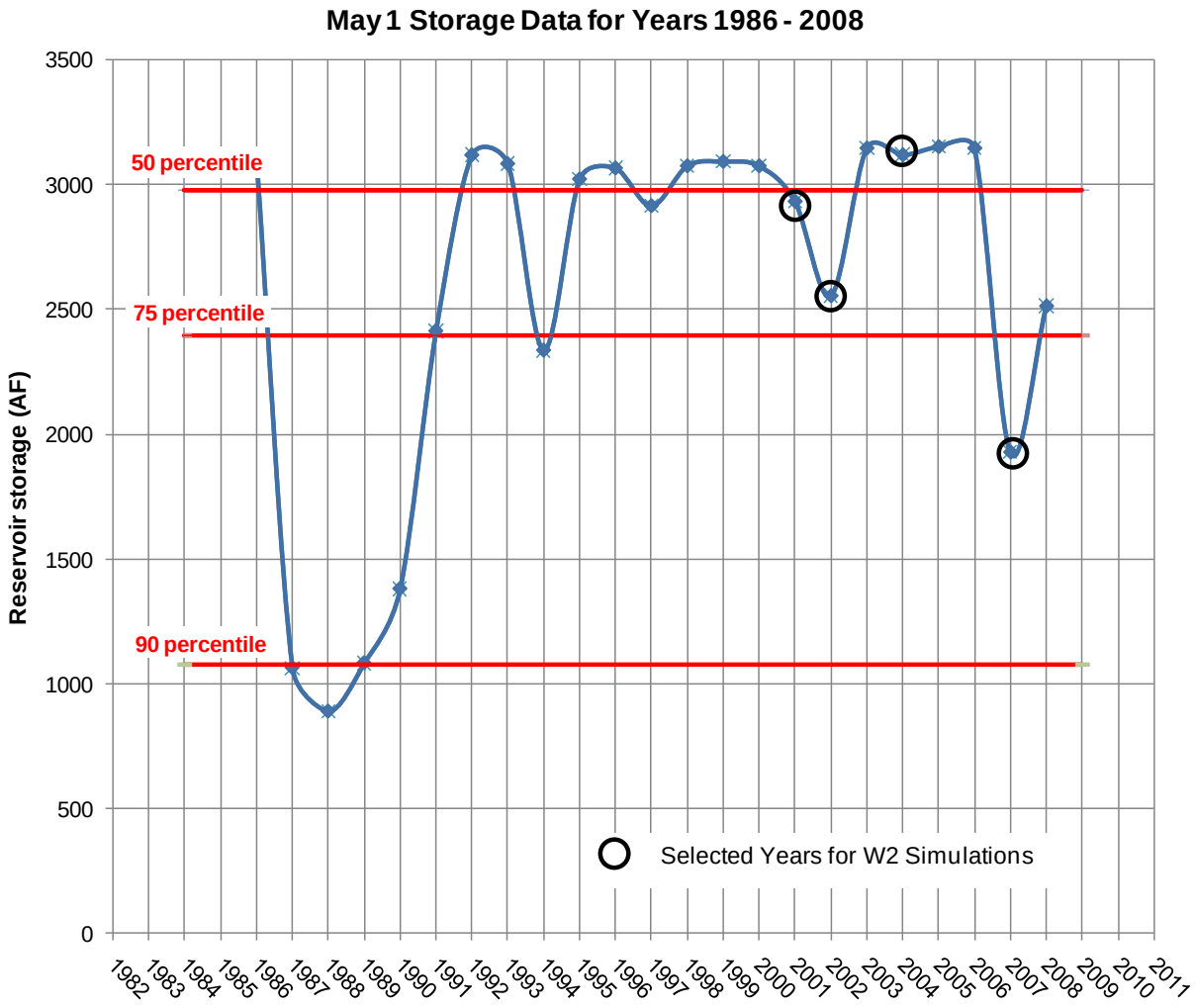


Figure 1 Statistical analysis of May 1 storage data for years 1986 – 2008

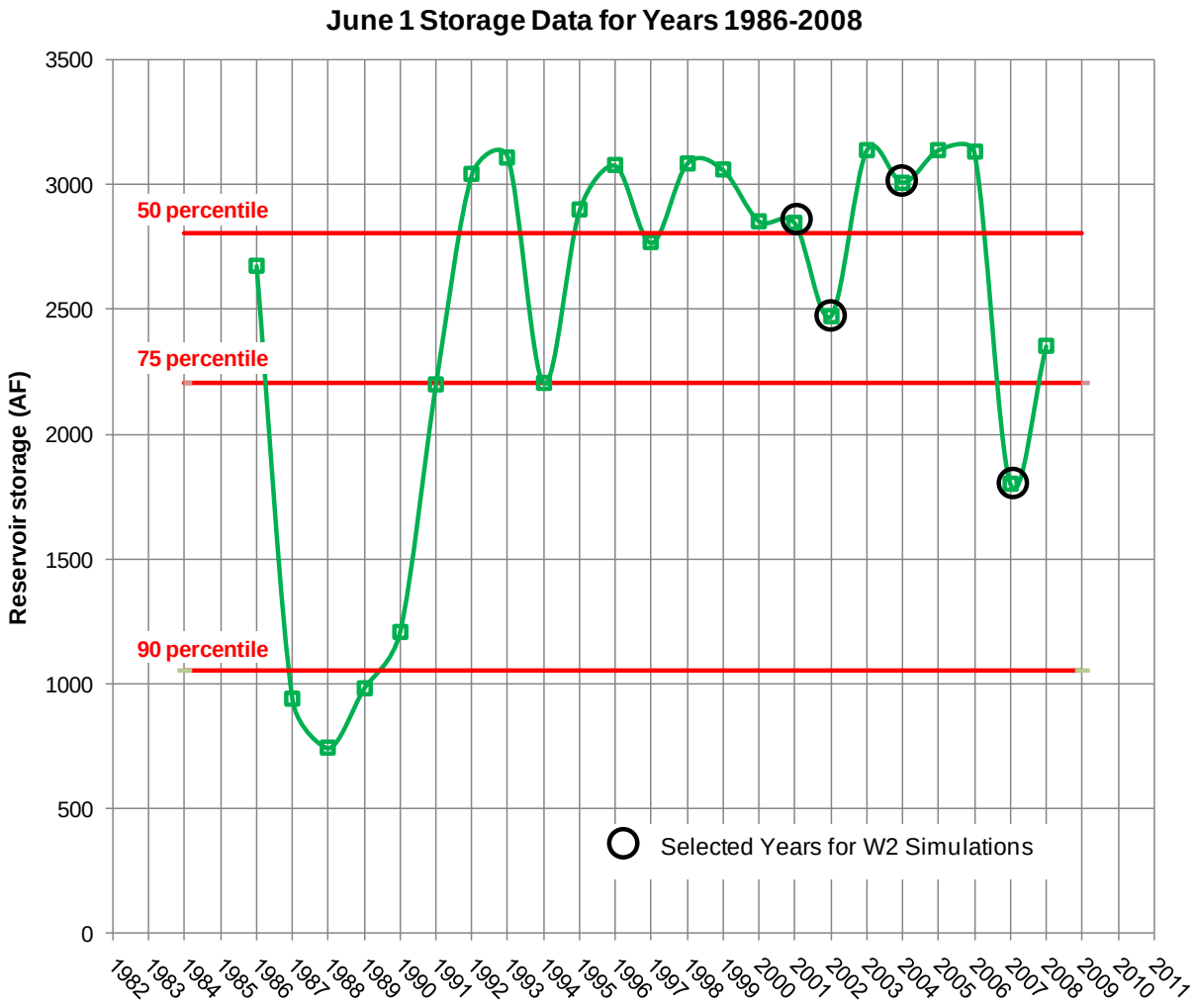


Figure 2 Statistical analysis of June 1 storage data for years 1986 – 2008

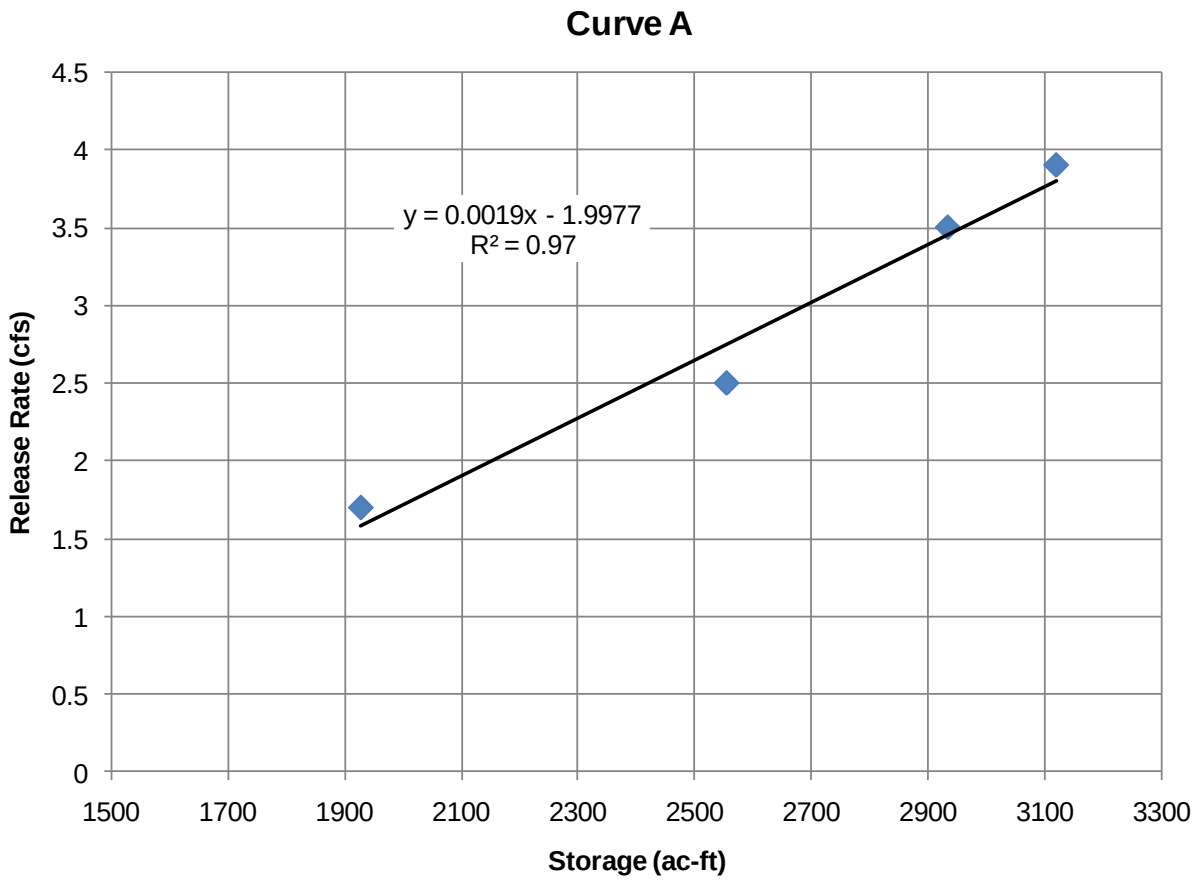


Figure 3 Curve A (DSA operating strategy, May 1 storage, average summer weather)

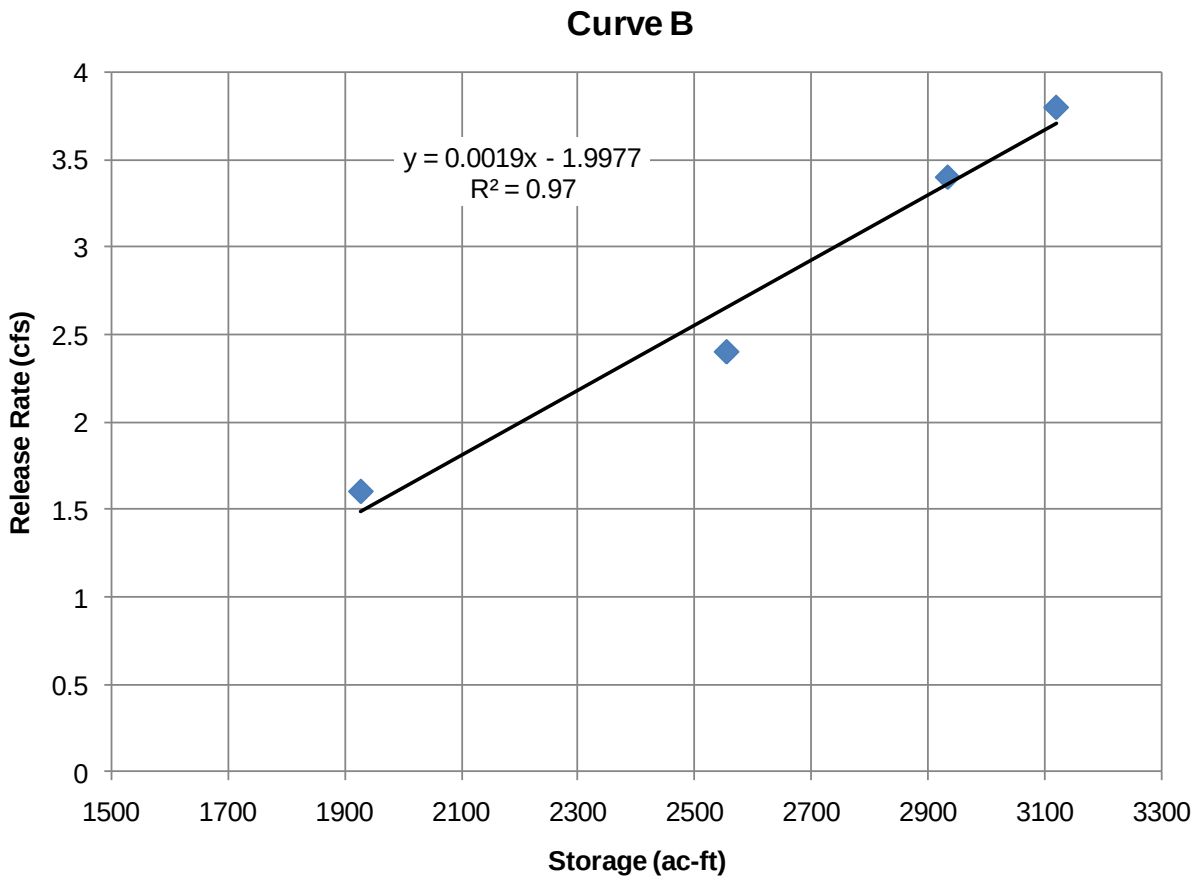


Figure 4 Curve B (DSA operating strategy, May 1 storage, extreme summer weather)

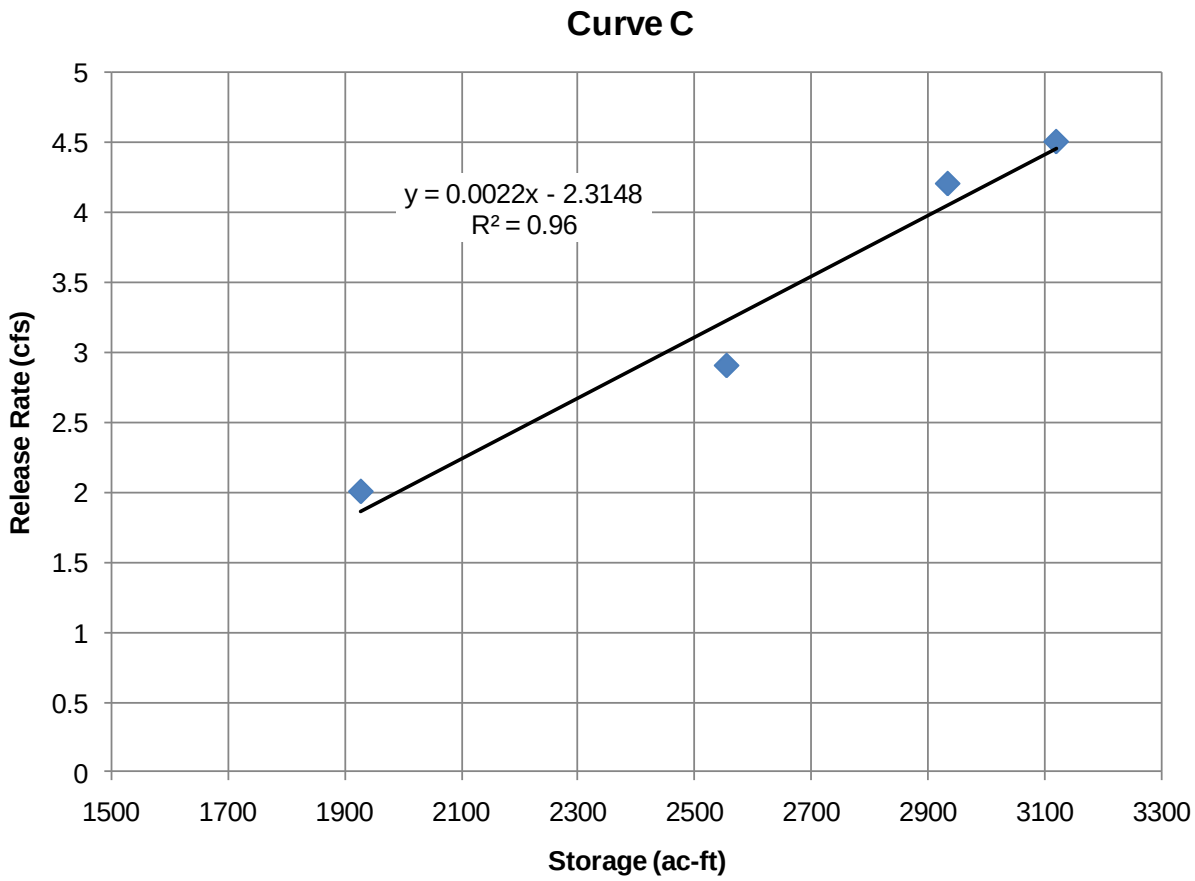


Figure 5 Curve C (DSA' relaxed creek temperature criteria and spring out-migration, May 1 storage, average summer weather)

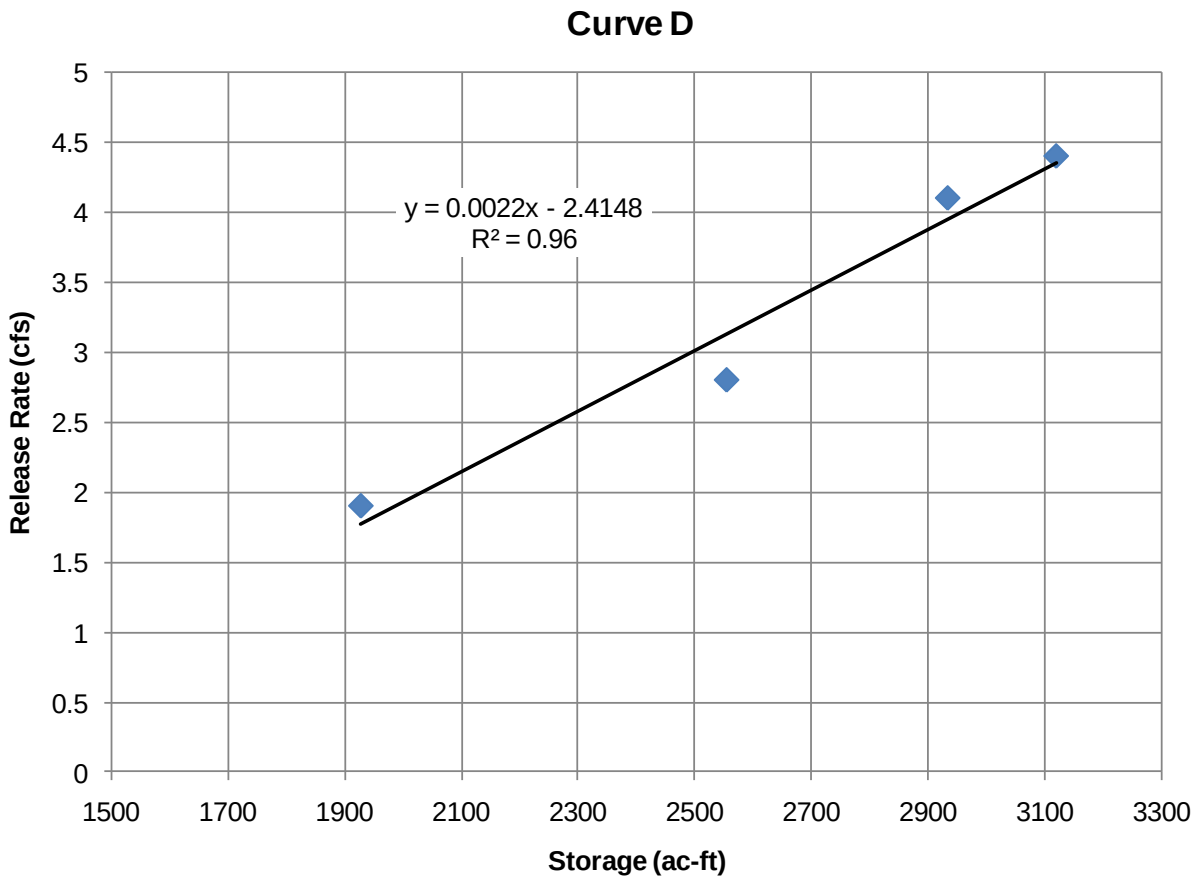


Figure 6 Curve D (DSA' relaxed creek temperature criteria and spring out-migration, May 1 storage, extreme summer weather)

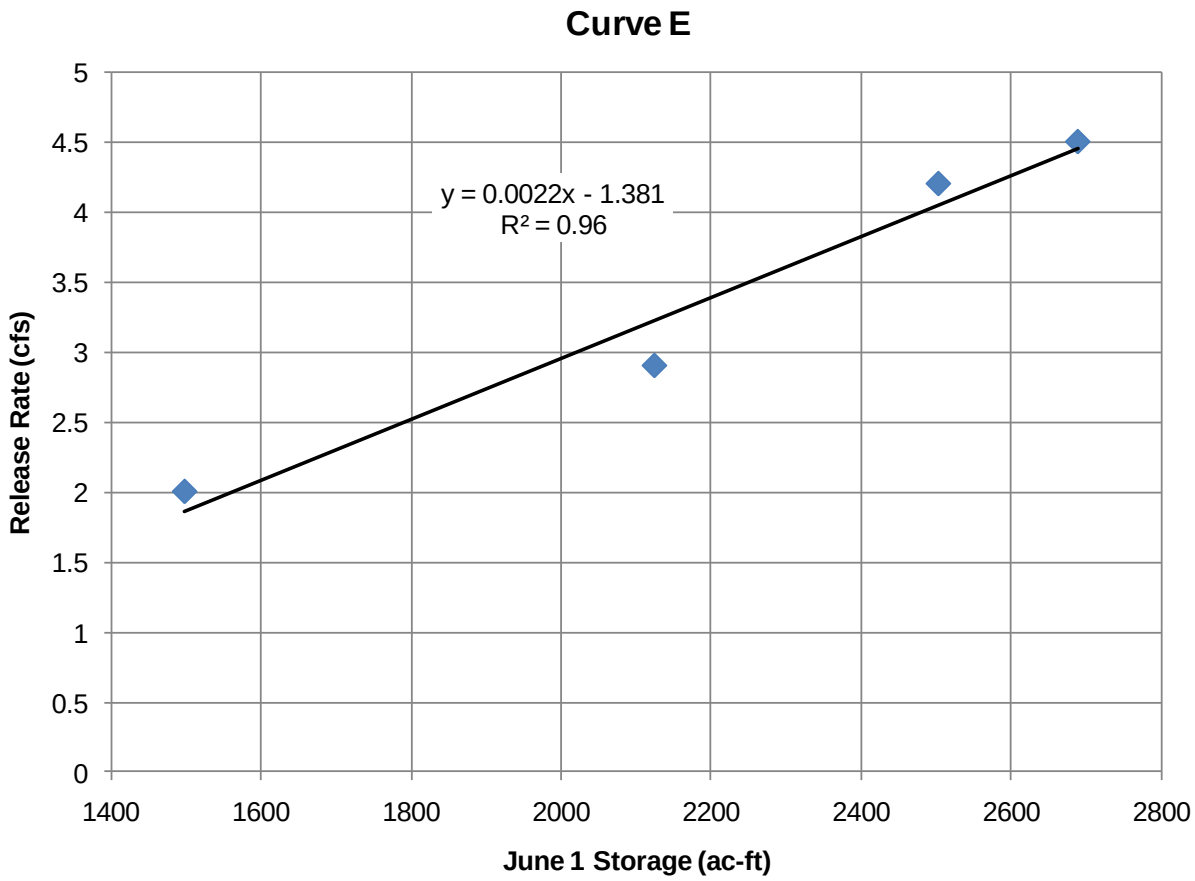


Figure 7 Curve E (DSA' relaxed creek temperature criteria and spring out-migration, June 1 storage, average summer weather)

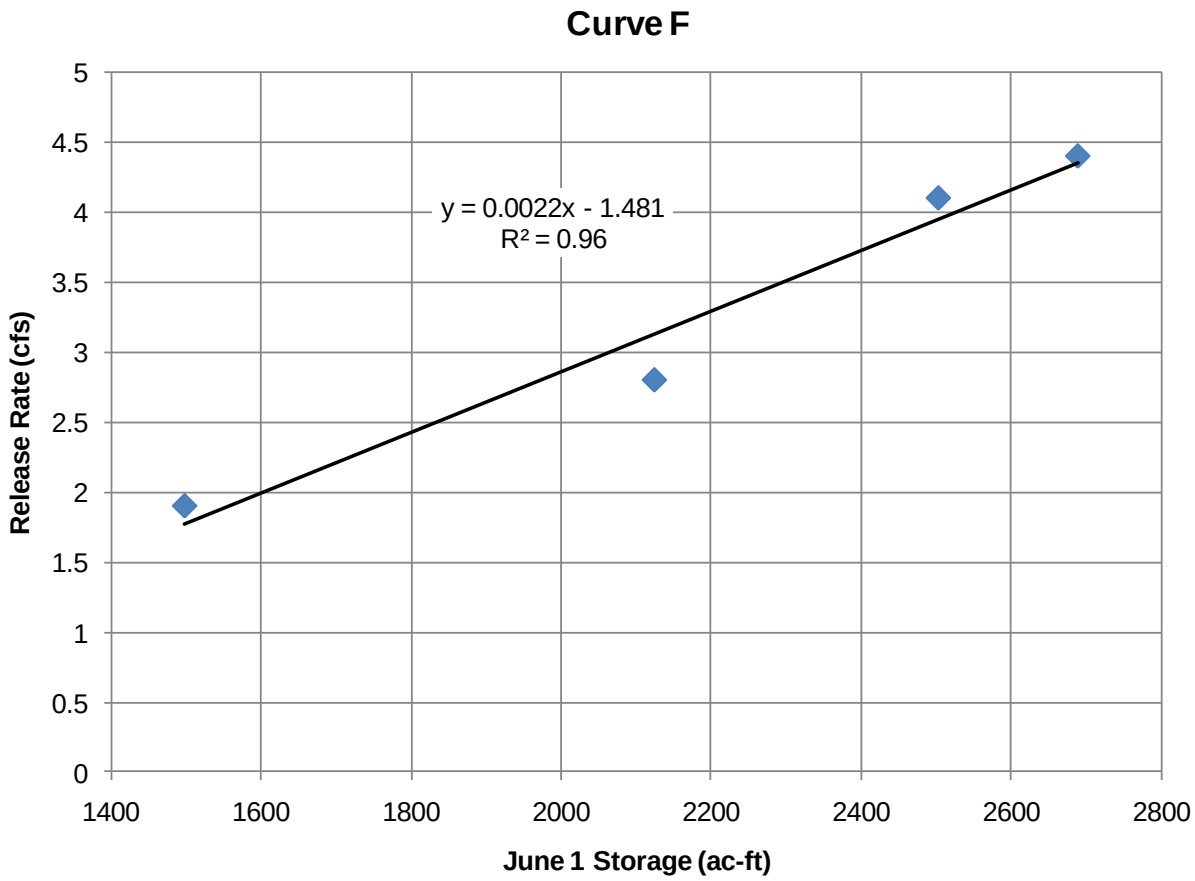


Figure 8 Curve F (DSA' relaxed creek temperature criteria and spring out-migration, June 1 storage, extreme summer weather)

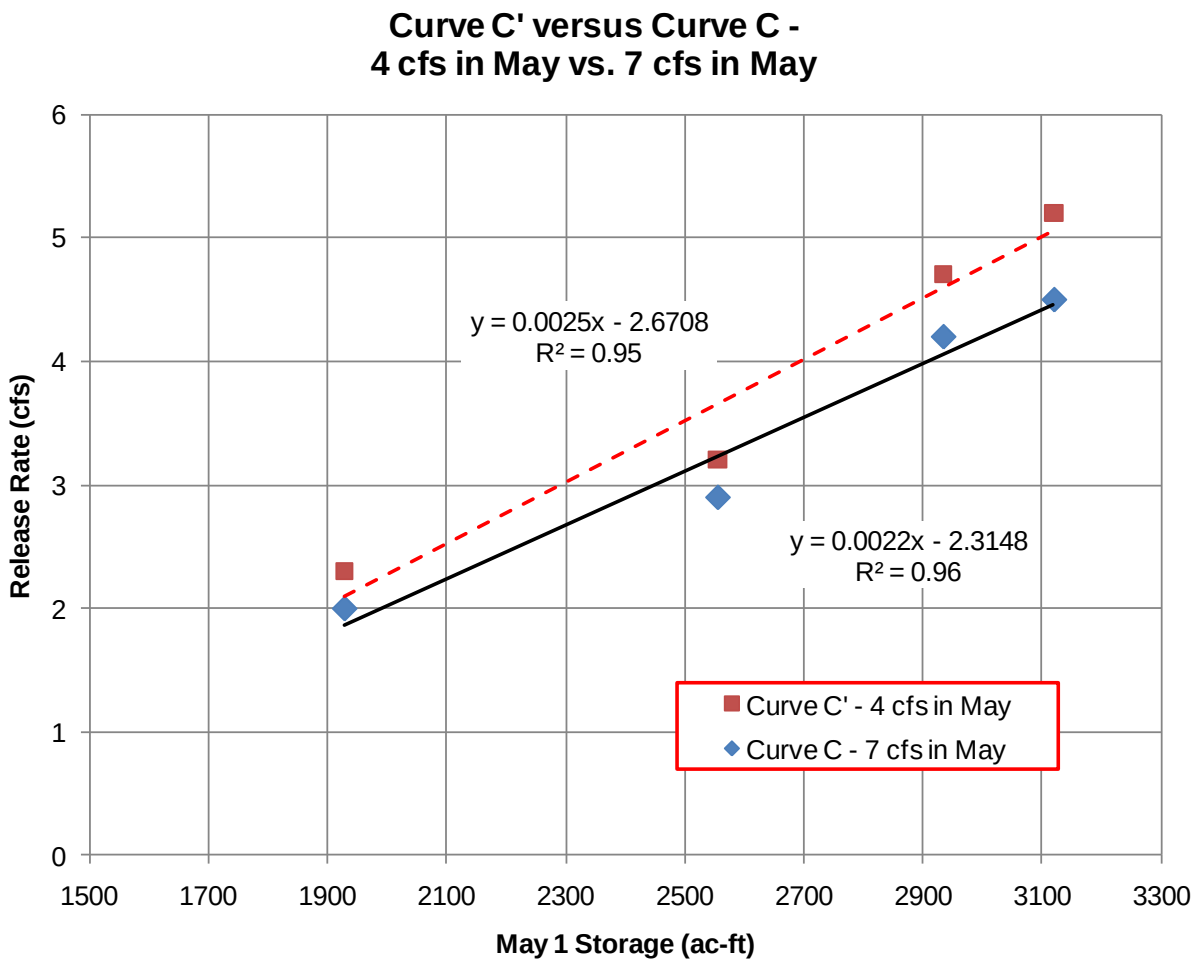


Figure 9 Comparison of Curve C' (4 cfs in May) and Curve C (7 cfs in May) for spring out-migration period, average summer weather

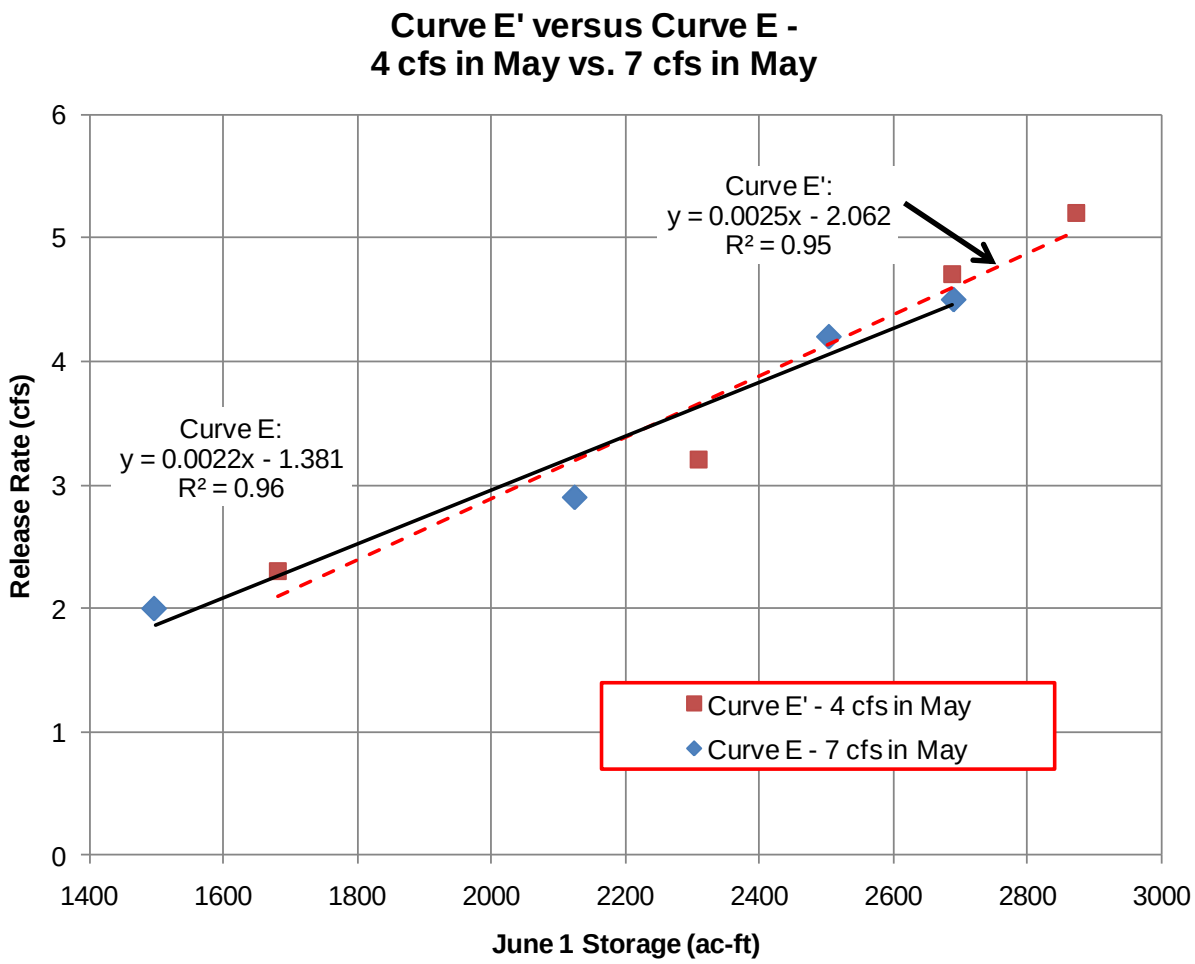


Figure 10 Comparison of Curve E' (4 cfs in May) and Curve E (7 cfs in May) for spring out-migration period, average summer weather